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Pan A. Yotopoulos

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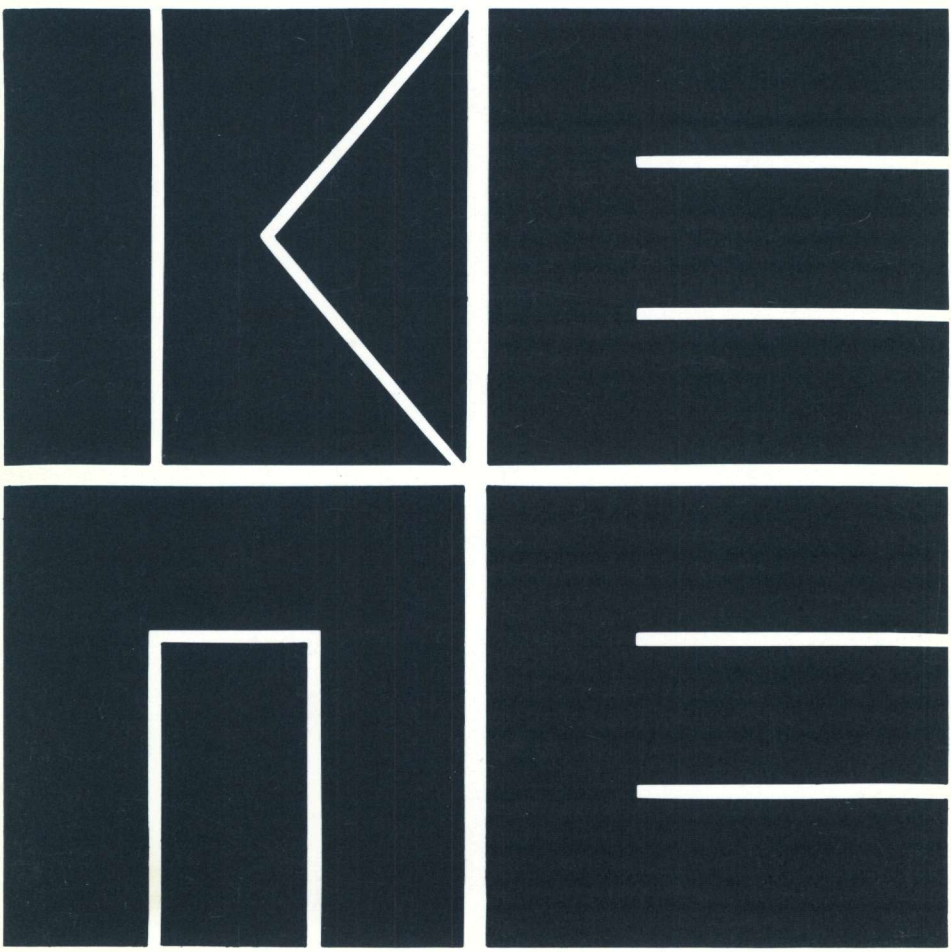

Athens 1984

Middle Income Classes and Food Crises

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Middle Income Classes and Food Crises:
The «New» Food-Feed Competition

Pan A. Yotopoulos
Professor of Economics

Athens, December 1984

CENTRE OF PLANNING AND ECONOMIC RESEARCH

The Centre of Planning and Economic Research (KEPE) was established as a research unit, under the title 'Centre of Economic Research', in 1959, Its primary aims were the scientific study of the problems of the Greek economy, encouragement of economic research and cooperation with other scientific institutions.

In 1964, the Centre acquired its present name and organizational structure, with the following additional objectives: (a) the preparation of short, medium and long-term development plans, including plans for regional and territorial development and also public investment plans, in accordance with guidelines laid down by the Government; (b) the analysis of current developments in the Greek economy along with appropriate short-term and medium-term forecasts; also, the formulation of proposals for appropriate stabilization and development measures; (c) the further education of young economists, particularly in the fields of planning and economic development.

The Centre has been and is very active in all of the above fields, and carries out systematic basic research in the problems of the Greek economy, formulates draft development plans, analyses and forecasts short-term and medium-term developments, grants scholarships for post-graduate studies in economics and planning and organizes lectures and seminars.

Within the framework of these activities, the Centre also publishes studies from research carried out at the Centre and lectures given by specially invited distinguished scientists.

The Centre is in continuous contact with similar scientific institutions abroad and exchanges publications, views and information on current economic topics and methods of economic research, thus further contributing to the advancement of the science of economics in the country.

PREFACE

In this series KEPE publishes lectures delivered at the Centre, shorter studies of a more general interest, and reprints of articles published by our staff in well-known greek and foreign journals.

Professor Yotopoulos' lecture, delivered in August 1983, deals with world hunger from a novel perspective. Instead of focussing on poverty or population growth as proximate causes of food crises, he looks at affluence. He examines the demand for grains both as a staple commodity for the low-income groups, and as derived demand for animal protein for the middle-income groups. Given the fact that the market for grains is unified, regardless of the ultimate use of grains, the policy implications of the case of market failure become pertinent: price rationing does not work, and direct intervention becomes necessary.

With as much as one-quarter of the world's population suffering from undernutrition, hunger has become a vital problem in development. The importance of the topic for Greece is also direct: growth has created an almost universal "middle-income class" and the attendant consumption of meat has grown at an annual rate of 5.1 percent in the last fifteen years.

Correspondingly, the use of grains for animal feed has grown at a rate of 7.5 percent, increasing a total of two-and-one-half times in a fifteen-year period. The result is that almost eighty percent of all grains consumed in the country go to animal feed.

Professor LOUKA T. KATSELI
Scientific Director

Centre of Planning
and Economic Research
December 1984

Hunger is a world problem which is both widespread and stubborn to solve. The classical ingredients of food crises -population growth, shortfalls in supplies and "entitlement failures", or poverty- have certainly contributed to the current state of hunger and undernutrition around the world. Yet, a paradoxical situation arises, since in the last twenty years agricultural growth, overall, far exceeded the rate of population growth, and real incomes in developing countries more than doubled. The phenomenon of increasing hunger and malnutrition in the midst of increasing affluence has been attributed to "problems of distribution".

This generalization is analyzed within the context of socio-economic classes, such as the poor and the middle-income classes, with reference to demand for their staple commodity, cereals to be consumed directly by the former, and mostly indirectly as feedgrain for the latter. Feedgrain use is derived demand originating mainly from the demand of the middle-income classes for animal protein. In the process of being fed to animals, grains are "squeezed" by a "grain-meat ratio" which is a function of the rate of development. So is the size of the middle-class population, and its income. How does development, and the growth of the middle-class, affect the ability of the poor to satisfy their direct demand for grains? The question is posed within the framework of a linked market demand for cereals for direct and for indirect consumption. The conclusion is that in the competition between the rich and the poor, relative affluence, for the first time has become one of the major claimants of world food supplies - and ironically a proximate cause for hunger in certain parts of the world!

Having nurtured the Centre of Planning and Economic Research - and having been nurtured by it- since its inception, in 1961, giving a lecture there always becomes a nostalgic homecoming. I am grateful to Professor Louka Katseli and to Professor Alexander Sarris for having also made the occasion warm and memorable and I would like to thank the staff for their insightful comments and constructive criticism.

PAN. A. YOTOPOULOS

Stanford, California
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ABSTRACT

"MIDDLE INCOME CLASSES AND FOOD CRISES: THE 'NEW' FOOD-FEED COMPETITION"

PAN. A. YOTOPOULOS*

Cereal demand for feedgrain use has been growing rapidly in relation to cereal demand for direct consumption - by 1.3 percent per year versus 0.4 percent, respectively, in the low-income developing countries and by 2.5 percent versus 0.7 percent per year in the middle-income developing countries. Feedgrain use is derived demand originating mainly from the demand of the middle-income classes for animal protein. How does the growth of middle-class populations and incomes affect the ability of the poor to satisfy their direct demand for grain? The question is posed within the framework of a linked market demand for cereals for direct and indirect consumption. The analysis is based on data from 125 countries over the last 15 years and on survey data on income and expenditure from Tunisia. The conclusion is that in the competition between the rich and the poor, relative affluence, for the first time, has become one of the major claimants of world food supplies.

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* The author is professor of economics at the Food Research Institute, Stanford University. This research was stimulated by a number of assignments for FAO over the last few years, but the views are the author's and do not necessarily reflect those of the Organization. I am grateful to N. Islam, M.H. Abbas, N. Alexandratos, J. Bruinsma and J. Périssé of FAO for helpful discussions and to M.G. Ottaviani-Carra and G.J. Mergos for invaluable research assistance. A. Apergis, W.O. Jones and B.F. Johnston commented on an earlier draft of this paper. Finally, the suggestions of an anonymous referee and those of colleagues at the Economic Development Research Centre, University of Warwick, England, prompted some important elaborations of the argument.

MIDDLE-INCOME CLASSES AND FOOD CRISES: THE 'NEW' FOOD-FEED COMPETITION

The World Food Crisis of 1972-74 was an atypical event in the annals of world agriculture. The surprise was not the crisis per se- famines have dotted the world's historical landscape often enough and, besides, in that specific case the famine was averted. The novel element was that a 3 percent shortfall in grain production led to a 250 percent price increase. This specific manifestation of the food crisis was the resultant of the concurrence of some old forces, such as population pressure, with some new, e.g. the incomes explosion and income inequality. In a world where the economic distance between the rich and the poor grows ever greater, even minor food episodes are likely to assume major proportions. The agricultural price instability that will ensue represents a major threat to the food security of less developed countries.

An examination of the ingredients of modern food crises can help explain some of the new ramifications of the age-old problem of world hunger. The three elements that are reflected in the food demand situation are population, incomes and prices. To avoid unnecessary complexity, prices will be overlooked for the moment. They will be reserved for a cursory examination at the end. The other two elements deserve more detailed analysis.

Demand for Food as Related to Population and per Capita Income

The demand for food is usually expressed as a function of population, per capita incomes and prices. More specificially, and ignoring prices for the moment,

$$D = Nq \qquad (1)$$

where D is total demand for food, N is population and q is demand for food per capita.

The per capita demand for food depends on per capita income

$$q = f(y) \tag{2}$$

where y is per capita income.

The change in per capita demand over time is given by the time derivative of (2)

$$\frac{\vartheta q}{\vartheta t}\frac{1}{q} = \frac{\vartheta q}{\vartheta y}\frac{y}{q} \cdot \frac{\vartheta y}{\vartheta t}\frac{1}{y} \tag{3}$$

Considering now total demand D, and its time derivative with respect to population and per capita demand for food, we write from (1)

$$\frac{\vartheta(Nq)}{\vartheta t}\frac{1}{Nq} = \frac{\vartheta N}{\vartheta t}\frac{1}{N} + \frac{\vartheta q}{\vartheta y}\frac{y}{q} \cdot \frac{\vartheta y}{\vartheta t}\frac{1}{y} \tag{4}$$

Redefining

$$\frac{\vartheta(Nq)}{\vartheta t}\frac{1}{Nq} = \dot{D},\ \frac{\vartheta N}{\vartheta t}\frac{1}{N} = \dot{N},\ \frac{\vartheta q}{\vartheta y}\frac{y}{q} = e, \text{ and } \frac{\vartheta y}{\vartheta t}\frac{1}{y} = \dot{y}$$

and by substitution in (4) we have

$$\dot{D} = \dot{N} + e\dot{y} \tag{5}$$

Equation (5) is the familiar time-rate relative-change equation where dots indicate time-change and the subscripted e's are the respective elasticities. The formulation of the equation in (1) and the time derivative in (5) assume that the population elasticity of demand is

equal to one. By the operation of Engel's law the income elasticity of demand, e, is almost certainly less than one[1]. Assigning such values to the relevant elasticities is consistent with conventional wisdom according to which population growth is the main culprit for the rapid increase in food demand. By consequence, it is population growth which contributes to food crises, to famines or to increases in the numbers of the undernourished in the world. Two factors are overlooked in this line of reasoning: the relative importance of the growth of population and income, and the fallacies of aggregation.

World population grew rapidly after World War II. More recently, the average annual rate of population growth for the 1960s and the 1970s, was 2.3 and 2.2 percent respectively for LDCs and 1.0 and 0.7 percent for DCs. The resulting demographic explosion has had no precedent in history. Approximately 130 years were needed after 1800 to add a second billion to world population. Only 15 years were needed after 1960 to add a fourth billion, with a world population numbering 4.4 billion in 1980. The foundation for this unprecedented rise in world population was laid by a most welcome biological spin-off of World War II. The development of penicillin and antibiotics heralded a revolution in the technology of death control, with the LDCs becoming the major beneficiaries of dramatic decreases in morbidity and especially in infant mortality[2].

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1. Some of the typical values assigned to that elasticity range from 0.4 to 0.8. See J.W. Mellor, *The Economics of Agricultural Development* (Ithaca, N.Y.: Cornell University, 1966); J.W. Mellor, "Third World Development: Food, Employment and Growth Interactions", *American Journal of Agricultural Economics*, 64 (May 1982): 304-11; A.M. Tang, "Food and Agriculture in China: Trends and Projections, 1952-77 and 2000", eds. A.M. Tang and B. Stone, *Food Production in the People's Republic of China* (Washington, D.C.: International Food Policy Research Institute, Research Report No. 15, May 1980): 11-81.

2. For selected LDCs, as an example, the decrease in infant mortality between 1935-39 and 1960-64 was of the order of 45 to 80 percent, with the new level ranging from 25 per thousand to 80 per thousand. This compares with a modal value of 20 per thousand for middle-income countries and DCs. S.H. Preston, "Empirical Analysis of the Contribution of Age Composition to Population Growth", *Demography* 7 (November 1980): 417-432; L.F. Bouvier and J. van der Tak, "Infant Mortality-Progress and Problems", *Population Bulletin* 31 (April 1976): 1-33.

The income gains of the last two decades far outdistanced the population increases. While population grew by about a half (44 percent), per capita incomes roughly doubled between 1960 and 1980. More specifically, GDP per capita grew at an annual rate of 3.9 percent in the 1960s and of about 2.4 percent in the 1970s in the market DCs. The corresponding figures for the LDCs were 3.1 and 2.9 percent respectively. Incomes in the centrally planned economies were increasing at a rate of 4.4 percent per year in the same period[3].

The dramatic increase in incomes since 1960 was coupled with an equally impressive performance of world agriculture. The average annual rate of growth for the LDCs was 2.9 percent for the period 1963-80. This is higher than the rate of growth of population. Yet the diets in LDCs barely improved and the number of undernourished people probably increased. According to estimates of FAO for the mid-1970s the seriously undernourished exceeded 15 percent of the total population in 55 countries of the world. These people numbered some 436 million[4]. The World Bank, on the other hand, estimates that one billion of the world's population was undernourished in 1980[5].

The irony of the situation is that in some basic sense the world as a whole, most nations in general and most individuals in particular, are richer today than they have ever been before in the entire span of human history. Yet the world food problem may be as grave today as it ever was. This, obviously, would have never been the case if population alone and/or poverty were the principal causes of hunger. No satisfactory explanation of this conundrum has ever been offered, aside from general statements to the effect that hunger is a question of «distribution». The fallacies of aggregation alluded to earlier refer in a sense to these "distributional" problems.

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3. World Bank, *World Development Report 1981* (New York, N.Y.: Oxford University, 1981).

4. Food and Agriculture Organization, *Agriculture: Toward 2000* (Rome: Food and Agriculture Organization, 1981).

5. This number includes an estimated 150 million undernourished in China, which the FAO estimate excludes. World Bank, *World Development Report 1981.*

There are three fallacies of aggregation implicit in the conventional apportioning of demand between population and income. First, aggregation at the level of all food conceals the fact that people consume a *mix of commodities,* rather than "food". Second, both the mix of commodities and their elasticities of demand are bound to change at different income levels. Incomes, therefore, and their respective elasticities, should be disaggregated to distinguish the relevant *socioeconomic classes,* say, as a minimum, the rich and the poor. Third, population is a non-homogeneous variable, consisting also of rich and poor. The same increase in population would have one kind of impact on the demand for food if it occurred among the poor and a different one if it took place among the rich. More generally, the model must recognize the *graduation* of population into socioeconomic classes, whether that occurs as a result of incomes growth or because of (differential) class-specific population growth[6].

The empirical analysis that follows intends to examine the interactions between income and population growth as they affect the demand for food while taking into account the commodity mix and the variance in incomes among socioeconomic classes. The issue of graduation into socioeconomic classes is addressed in the next section.

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6. The three components of disaggregation have been treated in the empirical literature either singly or in general but not jointly and for the purpose of projecting food demand and grain deficits. For example, Food and Agriculture Organization, *Agriculture: Toward 2000* treats separately 28 crop and 6 livestock products. A.M. Tang, "Food and Agriculture in China: Trends and Projections, 1952-77 and 2000" is very careful in distinguishing, for projection purposes, between direct demand for food grains and indirect demand for feed grains. Tang also recognizes the impact of changing age composition and of the urban/rural mix of population on food demand. Income distribution and socioeconomic class size, however, are not related to direct and indirect demand, which may not be an important omission in a basically egalitarian society. The only reference that could be found on the relation between the size of the middle-income class and consumption patterns (broadly defined as consumption of world's material resources) is N. Keyfitz, "World Resources and the World Middle Class" *Scientific American* 235 (July 1976): 28-35.

Demand for Food or for Feed? Results from International Cross Sections

It is convenient to concentrate on cereals when studying the growth in the demand for agricultural commodities. Moreover, by breaking down the demand for cereals into direct (food) and indirect (feed) use, one captures the staple commodity for both ends of the income distribution scale, i.e. the poor and the rich. Cereals (wheat, rice and coarse grains) are the major source of calorie intake at low income levels. In fact, at a relatively low level of subsistence cereal consumption is a good proxy for nutritional adequacy[7]. At higher levels of income cereals also feature prominently in the human diet. The only difference is that cereals (mostly coarse, but also some wheat) are consumed indirectly in the form of animal protein.

The move from direct to indirect cereal consumption as incomes increase represents a move up the food chain and changes the composition of the food basket between plant and animal protein. This move to higher rungs of the food ladder is common and is fully handled by Engel's law. The only new element added here is that, in the process of changing the food basket mix, the total supply of cereals available shrinks. The animal stomach is a rather inefficient converter of protein. The relevant calorie-equivalent grain-meat conversion ratios vary from $2 \div 1$ for poultry to $7 \div 1$ for feedlot-fed beef. Moreover, the conversion ratio itself changes in the process of development since the mix of animal protein between, say, poultry and beef depends on the level of income.

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7. A study with international cross-section data from LDCs concludes that "The proportion of cereals in calorie equivalent for 1972/74 ranges from 85 percent in Afganistan to 16 percent in Zaire. For 50 out of the 94 countries studied the share of cereals is above 50 percent of total calorie consumption. Cereals are dominant in the consumption basket in Asia while in Africa and in Latin America the role of non-cereals is also vey important". A. Valdés and P. Konandreas, "Assessing Food Insecurity Based on National Aggregates in Developing Countries", *Food Security in Developing Countries*, ed. A. Valdés (Boulder, Colo.: Westview Press, 1981): 27.

The problem with estimating demand for cereals -even worse, demand for total gross value of agricultural production- without distinguishing between the poor and the rich and between direct and indirect cereal consumption, is precisely that the former is limited while the latter is not. There is only so much cereal that can be consumed directly to provide an adequate nutritional intake - something less than 200 kg per capita per year[8]. The variation is much greater when indirect cereal consumption is also considered, with the average per capita rising to 550 kg per year in W. Europe and 850 kg per year in the U.S. The situation is illustrated in Figure 1. Food is consumed directly. At the low income levels of the poor it has the characteristics of the "necessity good". It is also consumed by the middle income classes and the wealthy, but at higher income levels some substitution of animal protein for direct consumption of cereals occurs. Feed, on the other hand, represents a "luxury", consumed indirectly mainly by the higher-income classes. It is represented by the curve having a sigmoid shape. The point is that by ignoring the distinction between the poor and the rich and aggregating the food and feed demand curves, one gets the total demand curve that represents a polynomial of higher order. Such curves, unless broken down to their basic components, are difficult to use for predictions since their turning points cannot be determined with accuracy.

Table 1 utilizes data from the Food and Agriculture Organization (FAO) in order to break down total demand for cereals into the two components, direct consumption (food) and indirect consumption (feed). The table presents for total demand and also for food and feed the aggregates for 1980 and the annual rates of growth, 1966-80[9], for groups of countries. A number of interesting observations emanate from the data.

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8. For an illustration of direct cereal consumption per capita in countries with different levels of income, see L.B. Brown, "Population and Affluence: Growing Pressures on World's Food Resources", *Population Bulletin* 29.

9. The end-points are actually three-year averages, 1966-68 and 1978-80, for the sake of smoothing out short-term fluctuations.

TABLE 1

Demand for Cereals, Aggregate 1980 and Rates of Growth 1966-1980 (Million metric tons and percent)

	Number of Countries[1]	Aggregate 1980			Rates of Growth 1966-80		
		Total Demand[2]	Food	Feed	Total Demand[2]	Food	Feed
Less Developed	90	439.6	328.1	58.1	3.3	3.1	5.3
Low LDCs	40	238.1	207.6	4.7	2.8	2.9	3.8
Middle LDCs	50	201.4	120.5	54.0	3.9	3.5	5.4
Africa	37	54.8	44.3	3.1	2.6	2.9	6.2
L. America	24	87.1	45.6	33.1	3.9	3.3	5.2
N. East	14	68.0	40.8	14.6	4.0	3.6	4.5
Asia and Far East	15	229.6	197.5	7.9	3.0	3.0	6.6
Developed	34	749.6	174.2	466.7	2.0	0.6	2.7
Market DCs	26	437.6	104.0	287.5	1.4	1.0	1.3
Centrally Planned DCs	8	312.0	70.2	179.1	3.0	0.1	5.5
China	1	234.2	177.9	38.2	3.3	3.2	4.3
Total	125	1432.4	680.2	562.9			

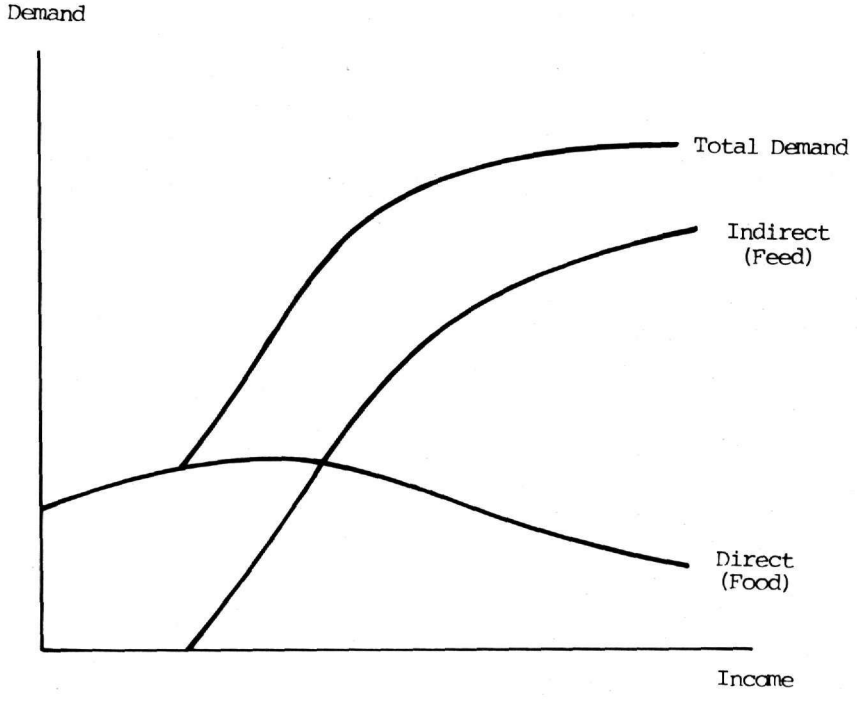
1. China is excluded form the groupings of both DCs and LDCs. Low LDCs are those with per capita income in 1975 less than $370. The others are defined as middle-income LDCs.

2. Total demand, besides food and feed, also includes residual uses such as industrial, seed, waste, etc.

Source: Food and Agriculture Organization, "Supply Utilization Accounts" (files).

FIGURE 1

Demand for Cereals, Total, Direct and Indirect, According to Income



At the aggregate level the importance of cereal use for feed is striking. Of the total world consumption of cereals feed accounts for 39 percent, food for 47 percent and other uses, such as industrial, seed, etc., for 14 percent. The developed countries, including both market and socialist economies, are responsible for the preponderant use of feed, amounting to 83 percent of the total. In fact the 467 million metric tons of feed consumed by the 26 percent of the world's population that lives in the developed countries is almost equal to the total amount of cereals consumed directly (food) by the remaining 74 percent of the world's consumers. Next in importance, as regards the consumption of feed, are the middle-income LDCs, with a total of 54 million metric tons of feed consumed in 1980, followed by China with 38 million m.t., and last the forty low-income LDCs which consumed a mere 5 million m.t. of feed in 1980. The table reveals that by 1980 animals were playing a very considerable role in the global picture of cereal consumption.

The rates of growth of total demand for cereals and of its two components in Table 1 broadly confirm the hypothesis suggested earlier, i.e., that beyond a certain income level the demand for direct consumption gets saturated and any increases in demand for cereals represent an improvement in diets through the consumption of animal protein. As the calorie-equivalent grain-meat conversion rates are of the order 2÷1 to 7÷1, the weight that feed-use assumes in total cereal demand increases rapidly - or, in other words, the amount of cereals available for direct consumption "shrinks" quickly. The low rates of growth of direct consumption of cereals in the DCs (below one percent per year) and the correspondingly high rates of growth of feed-use (2.7 percent per year for all DCs, and 5.5 percent for the centrally-planned DCs) are evidence of this trend. Moreover, the middle-income LDCs, having started from low initial consumption of animal protein, show a high rate of growth in feed consumption, not dissimilar to that in the centrally-planned DCs. The direct consumption of cereals, however, also increases at relatively high rates in middle-income LDCs to account for reductions in the (absolute) number of the undernourished and for population growth.

Population growth has been entirely ignored in Table 1. To the

extent that different groups of countries differ in population growth, the rates of change in Table 1 are not strictly comparable across groups. We need therefore to normalize for rates of growth in population. A convenient way is to assume that the elasticity of demand with respect to population is equal to 1 and, by rewriting equation (5) above, to estimate the income elasticity of demand as

$$e = \frac{\dot{D} - \dot{N}}{\dot{y}} \qquad (6)$$

The data and the respective elasticities appear in Table 2.

The data illustrate the two fallacies of aggregation mentioned earlier. They underscore the point that demand for cereals used for direct consumption is entirely different from demand for cereals used for animal feed, from the point of view of economic characteristics. At low levels of income the demand for food swamps that for feed (Table 1). As incomes grow, however, demand for feed, with a high income elasticity, rises fast. The income elasticity of demand for food, on the other hand, declines with increasing incomes. These observations are true for all groups of countries distinguished in Table 2. The LDCs, starting from low levels of nutrition, would be expected to devote any increases in income primarily to direct consumption. Nevertheless, even there, the income elasticities of the demand for feed are much higher than those for food - approaching one. A dramatic example is provided by Africa, where per capita feed-use increased with an income elasticity close to one. Yet total demand (equal to total cereal availability) declined by 0.3 percent. In order to accommodate the increase in feed-use in the face of declining per capita supplies, food demand remained static and the resulting income elasticity of total demand is -0.11. The case of Africa illustrates the peculiar nature of the income elasticities of Table 2. They are *ex post* elasticities, having been estimated from disequilibrium market data. A shortfall in per capita supply is not necessarily shared equally by proportional decreases in food and feed. On the contrary, when feed-use increases, food-use is crowded out resulting in unusual negative income elasticities of demand.

TABLE 2

Annual Rates of Growth of Per Capita GDP and Per Capita Demand for Cereals, 1966-1980 (Percent)

	Number of Countries[1]	Per Capita Growth Rates				Income Elasticities[2]		
		Total Demand[3]	Food	Feed	GDP	Total Demand[3]	Food	Feed
Less Developed	90	0.7	0.5	2.6	3.51	0.20	0.14	0.74
Low LDCs	40	0.3	0.4	1.3	1.73	0.17	0.23	0.75
Middle LDCs	50	1.0	0.7	2.5	3.98	0.25	0.18	0.63
Africa	37	-0.3	0.0	3.3	2.65	-0.11	0.0	0.94
L. America	24	1.2	0.6	2.5	3.36	0.36	0.18	0.74
N. East	14	1.2	0.8	1.8	4.62	0.26	0.17	0.39
Asia and Far East	15	0.5	0.6	4.0	3.03	0.17	0.20	1.32
Developed	34	1.2	-0.2	1.8	3.39	0.35	-0.06	0.53
Market DCs	26	0.5	0.1	0.4	2.95	0.17	0.03	0.14
Centrally Planned DCs	8	2.2	-0.7	4.6	5.95	0.37	-0.12	0.77

1. The low LDCs are those with per capita income in 1970 less than $370. The others are defined as middle LDCs.

2. Income elasticities have been estimated from the equation $e = \frac{D - N}{\dot{y}}$ where the numerator is the annual rate of growth in per capita demand and $\dot{y}$ is the per capita GDP growth rate.

3. Total demand, besides food and feed, also includes residual uses such as industrial, seed, waste, etc.

Sources: GDP: United Nations, *Handbook of World Development Statistics, 1980: Major Economic Indicators Showing Historical Development Trends,* (New York, N.Y.: U.N.: PPS/Q1R/5/1080, March 1981).
GDP for Centrally Planned Economies: Food and Agriculture Organization, *Gross Domestic Product, Private Consumption Expenditure and Agricultural GDP at 1975 Constant Prices. Historical Series 1960-75 and Projections 1975-1990,* (Rome: ESC/ACP/WD/76/2 Rev. March 1977).
Countries for which data are missing are:
Cuba, Lebanon, Yemen Arab Rep., Yemen PDR, Laos, Kampuchea, Korea DPR, Viet-Nam, Israel and Yugoslavia.

The DCs illustrate the case of satiation of direct demand, with very low income elasticities, and of levelling off of feed demand also at high consumption levels. The centrally-planned economies share the former feature. In fact, the attempt by the socialist countries in recent years to improve diets has led to an income elasticity of the demand for feed of almost 0.8. Since relative nutritional egalitarianism pre-existed in the centrally-planned economies, with little under-nutrition, the increase in meat consumption substituted to a certain extent for direct food consumption, the income elasticity of which became negative.

The striking feature of Table 2 is the high elasticity of demand for feed in all groups of countries, with the exception of the market DCs and the Near East. Should not differences in income warrant greater variance in the respective elasticities? This question cannot be answered with the data of Tables 1 and 2. Average per capita incomes and their growth rates, which underlie the country groupings in the tables, cannot adequately capture the two factors that account for the increase in feed-use: the size of the middle-income class along with its rate of growth, and the rate at which middle-class incomes increase. A relatively small increase in per capita income can lead to a sizeable increase in indirect demand for feed-use, if growth has mostly favored the incomes of the near-poor with large numbers graduating into the middle-income class and to animal-protein diets. Similarly, if growth in LDCs centers around middle-class incomes, the measured overall income elasticity of demand for feed would be expected to be close to that of higher-income countries which have more sizeable middle-income classes.

The argument above calls for disaggregating population and per capita income in equation (1) and studying their respective dynamics in equation (5). Only then the "graduation rules" into different socioeconomic classes can be determined. Unhappily, the data on socioeconomic class sizes and on their respective incomes and patterns of consumption, which would be needed to determine which classes benefit from economic development, and by how much, are not available. The discussion, however, can be advanced at the conceptual level and can be further illustrated with some recent data from Tunisia.

Graduation or the Role of the Middle-Income Class

The demand relationships of the earlier sections can be expressed so that they distinguish different socioeconomic groups i. We rewrite equation (1)

$$D = N_1q_1 + ... + N_iq_i = \sum_i N_iq_i \tag{7}$$

$$\frac{d(N_iq_i)}{dt} = \frac{\vartheta N_i}{\vartheta t}q_i + \frac{\vartheta q_i}{\vartheta t}N_i = N_iq_i\left[\frac{\vartheta N_i}{\vartheta t}\frac{1}{N_i} + \frac{\vartheta q_i}{\vartheta t}\frac{1}{q_i}\right] \tag{8}$$

and substituting from (3) and redefining as earlier, we have

$$\frac{D(N_iq_i)}{dt} = N_iq_i(\dot{N}_i + e_i\dot{y}_i) \tag{9}$$

Taking sums and dividing through by $\frac{1}{Nq}$, we have

$$\frac{d(Nq)}{dt}\frac{1}{Nq} = \sum_i \frac{N_iq_i}{Nq}(\dot{N}_i + e_i\dot{y}_i)$$

or

$$\dot{D} = \sum_i \frac{N_i}{N}\frac{q_i}{q}(\dot{N}_i + e_i\dot{y}_i) \tag{10}$$

Two cases can be distinguished in equation (10). If population (class size) growth is "neutral", all income classes increase proportionally through time and the graduation effect does not change the socioeconomic class composition, $\frac{N_i}{N}$. The change in demand in this case is equal to the change in population plus the component determined by the income elasticity of demand as weighted by the

proportion of the consumption of each income class in total consumption. In other words

$$\dot{D}=\dot{N}+\sum_i \frac{N_i}{N}\frac{q_i}{q}(e_i\dot{y}_i) \qquad (11)$$

With population (class size) growth "non-neutral" the equation becomes

$$\dot{D}=\sum_i \frac{N_i}{N}\frac{q_i}{q}\dot{N}_i+\sum \frac{N_i}{N}\frac{q_i}{q}(e_i\dot{y}_i) \qquad (12)$$

Equations (11) and (12) describe the impact of the "graduation" effect. Consider for simplicity a society that consists of three classes, the "poor", the "middle-income" and the "rich". People "graduate" into an income class either as a result of increases in income or by being born into that class; in either case they "acquire" the incomes (and average consumption) of the parent population. The elasticity of demand with respect to income is crucial in determining the change in total demand, over and above the effect of population growth. If, for example, upon entering the middle-income class, people "shrink" cereals by a high calorie-equivalent grain-meat conversion rate for consumption of animal protein, the elasticity of demand is high and the share of the middle-income class in total consumption increases. The corresponding increase in demand will be much greater than the population growth rate. The effect will be even larger if the size of the middle-income class increases relative to total population as incomes grow.

The data necessary for estimating equation (12) for direct and indirect consumption separately for each socioeconomic class are population and quantities consumed, aggregate as well as by class, and also class income, class population and their changes. Unfortunately panel data are not available on population, income and demand by socioeconomic classes. The alternative is to tabulate a simpler form of equation (12) with Tunisian data where we control for income by distinguishing ten income cells of the population and we weigh by the

population share of each cell in total population. The data have been taken from the national income and expenditure survey of 1975[10]. The consumption data that are relevant for our calculation are reported in physical quantities for cereals, beef, mutton-goat, poultry, offal, milk and eggs. Cereals reported in the survey are used for direct consumption. The other commodities are converted to cereal-equivalent consumed indirectly as animal feed by using country-specific feed-mix information[11].

Table 3 defines the income cells and presents average income and population for each cell by rural and urban residence and for total. The food consumption that corresponds to each decile was also given and the indirect use of feed was estimated for each cell in the manner described above. Given the small number of observations available in the data -the average income for each cell and the corresponding average per capita consumption- no rigorous statistical analysis was possible. An examination, however, of the income and consumption data by decile suggested the cut-off point for the three principal income classes. The "poor" were defined as those in the three lowest cells of the rural population distribution (incomes below 60.8 dinars) and those in the four bottom cells of the urban population distribution (incomes below 120.5 dinars). The seven cells of the "poor" together account for 42.4 of total population and have (weighted) average per capita income of 62.4 dinars. The next five cells in the rural population distribution (incomes between 60.9 and 156.7 dinars per capita) and the next four cells in the urban population distribution (incomes of 120.6 to 281.6 dinars per capita) were difined as "middle" class. The average per capita income of the middle class is 97.3 dinars. The two top cells of each distribution scale (incomes above 156.3 dinars for the rural and above 281.7 for the urban) were defined as "rich". The average per capita income for this class is 386.2 dinars.

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10. A. Kamoun, "Enquête nationale sur le budget et la consommation des ménages, 1975", (Tunis: Institut National de la Statistique, 1975).

11. Food and Agriculture Oreganization, "Food Composition Tables for International Use", Mimeographed (Rome: Food and Agriculture Organization, 1981).

TABLE 3

Tunisia 1974-1975: Total Population, Average and Per Capita Income by Income Class Deciles

TOTAL			RURAL			URBAN		
Per Capita Income	Average Income	Population	Per Capita Income	Average Income	Population	Per Capita Income	Average Income	Population
below 42.2	30.2	660,996	below 34.2	24.5	325,271	below 59.4	44.2	323,113
42.2- 59.6	51.0	653,431	34.2- 48.3	41.3	364,328	59.4- 83.2	70.2	326,832
59.7- 74.4	67.2	645,125	48.4- 60.8	53.9	321,272	83.3-100.0	91.5	345,345
74.5- 92.2	83.6	658,219	60.9- 72.7	66.7	333,104	100.1-120.3	110.9	331,993
92.3-110.9	101.1	668,480	72.8- 85.4	78.6	308,604	120.4-148.5	135.0	293,611
111.0-135.9	123.0	625,955	85.5-102.0	94.3	331,578	148.6-178.4	162.1	279,542
136.0-168.5	151.0	586,916	102.1-125.4	113.5	343,119	178.5-218.8	197.4	279,328
168.6-219.7	192.0	550,982	125.5-156.7	140.0	285,456	218.9-281.6	242.9	270,794
219.8-313.4	261.4	515,459	156.8-233.9	188.3	274,784	281.7-418.7	339.8	217,691
above 313.4	559.6	420,304	above 233.9	370.4	226,559	above 418.7	704.9	203,343
	143.1	5,985,867			3,114,075			2,871,792

Source: A. Kamoun, "Enquête nationale sur le budget et la consommation des ménages, 1975" (Tunis: Insistut National de la Statistique, 1975)

Table 4 presents the information on income and population as well as on the consumption of food and feed for each of the three socioeconomic classes. The average direct consumption of cereals (food) appears constant around 150 kg per capita per year for the three socioeconomic classes. The observation for the middle class and for the rich is consistent with a priori expectations that direct consumption asymptotically levels off at the satiation point as shown in Figure 1. One might have expected lower per capita consumption of food for the poor group. The observation, however, is consistent with the fact that Tunisia is among the countries with the lowest incidence of undernutrition, estimated at 262,000 persons or about 4 percent of the total population. Even at the lowest income cells, therefore, basic nutritional needs are probably met through the direct consumption of cereals.

The data on the indirect consumption of cereals (feed) are consistent with the sigmoid shape suggested in Figure 1. There is clearly an inflection point somewhere in the middle class income. A 56 percent increase in average per capita income from the income levels of the poor results in a 135 percent increase in feed-use, from 24.8 to 58.4 kg per capita per year. In the next income class, i.e. that of the rich, the increase in feed-use is only 81 percent, going up to 105.8 kg per capita per year.

Tunisia is a middle-income developing country with per capita GNP amounting to $1120 (1979) and an income distribution that leaves relatively few people undernourished. The direct consumption of cereals is around the top of the range by the standards of the DCs. Indirect cereal consumption for animal feed is on average just below 50 kg per year, which is low by the standards of the DCs. Yet this overall average conceals the great variation that exists within socioeconomic groups, from 25 to 106 kg per capita per year for the poor and the rich respectively. As incomes rise within a socioeconomic class and as people graduate into higher socioeconomic classes, the food-use of cereals would not be expected to change significantly. The feed-use of cereals, however, would grow dramatically. Most of the impact is expected to come from the middle-income class for two reasons. First,

TABLE 4

Population, Average Per Capita Income and Demand for Direct and Indirect Cereal Consumption by Socioeconomic Class, Tunisia, 1975

	Population		Per Capita Income	Annual Per Capita Consumption (kg)	
	(thousand)	(% of total)	(dinars)	Direct (Food)	Indirect (Feed)
"Poor"	2537	42.4	62.4	151.110	24.820
"Middle-Income Class"	2961	49.5	97.3	153.300	58.400
"Rich"	488	8.1	382.6	142.350	105.850
Total	5986	100.0	143.7	150.745	48.910

the middle-income class is the main beneficiary of development - the "graduation" income represents a 50 percent increase over the average incomes of the poor. Second, the elasticity of feed-use with respect to middle-class income is high - the value implicit in Table 4 is one.

The conclusion is that it is the middle-income class -literally the animals for middle-class consumption- that drives the cereal balance sheet in Tunisia. The situation in most other middle-income developing countries should not be much different, as suggested in the earlier sections.

The "New" Food-Feed Competition and the Role of Prices

The analysis both of international cross sections and of Tunisian household data points to the voracious appetite of middle-class consumers for animal protein, as an important determinant of the demand for cereals and as a driving force of the world food economy. This is the resultant of three conjoint factors: first, the income elasticities of demand for indirect cereal consumption by the middle-income class are high; second, the recent experience of development has led onto a massive graduation of population into the middle-income classes; third, and as a result of the previous two factors, the indirect demand of the middle-income classes for cereals is no longer trivial - as compared with the negligible cereal-share weight that the large low income class receives.

Is the food-feed controversy really new? After all, "sheep eat men" was the slogan of the English peasants dispossessed by enclosures in order to create fields for pasture. Besides, before the advent of the internal combustion engine, when man depended on animals for power and transportation, the competition between food and feed must have surely been more intense.

This is only partly correct. In the past, when animals were important in the economy, the competition between feed and food was only *indirect* and it was *localized.* Indirect, in the sense that it was

competition for the land on which to grow food or to grow feed. Today, it is competition for the land; but it is also direct competition for the final disposition of a quantity of grain produced between feed and food. This joint end-use of cereals has recently assumed important proportions. In Mexico, e.g., the quantity of corn going to feed in 1961-65 was 15 percent of that going to direct consumption; in 1977 it was 20 percent. On the other side of the coin, the quantity of soft grains fed to animals increased in the period 1966-1980 from 10 percent to 14 percent of total world output. Moreover, in the past, the competition was localized because transportation was expensive and it was more efficient to consume bulky commodities, such as animal meat or animal feed, at the source of supply. This is no more the case after the transportation revolution. For the first time, whether wheat produced in Australia will go to feed people in Bangladesh, pigs in the USSR, or sheep to be exported to the EEC becomes a question for the world market to determine.

In the traditional food-feed controversy it was animals that competed with people for feed versus food. Its modern variant has retained this aspect through the competition for land. But another dimension has also been added: people now compete with people for the indirect versus the direct consumption of cereals. In this competition between the rich and the poor, relative affluence, for the first time, has become one of the great claimants on world food supplies.

As the scope of competition increased, the role that prices play has correspondingly become more crucial. The setting of agricultural prices has always posed a dilemma in political economy. Food is the major item of expenditure of the urban and rural poor and therefore the price of food affects income distribution where it counts most, at the bottom of the scale. Low food prices, as a result, often become a political desideratum. Food prices, on the other hand, not only determine the incomes of the farmers but, more importantly, high prices provide the latter with incentives to invest more, to use more modern inputs and thus to produce more food. In this classical dilemma the modern variant of the food-feed competition has provided an additional wrinkle.

The dramatic increase in livestock herd -which has been reflected in an equally dramatic increase in the feed-use of cereals- provides added scope for adjustment of grain supplies for direct use in the case of a shortfall in production. This was illustrated by the drastic reduction in livestock feeding in the U.S. in response to the World Food Crisis of the early 1970s that drove up feed prices relative to meat prices[12]. The decrease in animal herd released grain for non-feed use both at home and abroad. Livestock in fact provided a cushion that served to dampen world market shocks by "stretching" the grains which were diverted from indirect to direct use. This was the short-run effect. In the long-run the outcome of the competition between the poor, who try to increase their direct consumption and the rich, who "shrink" cereals for indirect consumption as animal protein will be decided by their respective price and income elasticities of demand. The more inelastic with respect to income is the demand of the rich for indirect consumption, the greater the price increase that will be required to limit their use of cereals for animal feed. In a world where the soft and coarse grain markets are linked, a price increase in the latter would accomplish rationing the quantity of meat consumed by the rich. In the meantime it would also have two other effects. The price increase of coarse grains would be reflected in the soft grain market by diverting cereals to animal feed and by driving the prices of soft grains up. The price increase causes a decline in the real incomes of the poor and an attendant decrease in the qualities demanded. In the extreme case, and as a result of the combination of the respective price and income

12. As a result of the dramatic increase in the price of grains in the early 1970s, supplies of marginal qualities that were used for animal feed were released for direct consumption in LDCs. This shift was reflected in the U.S. in the higher prices of meat and in a decline in per capita meat consumption (excluding chicken) from 193 lbs in 1972 to 178 lbs in 1973. After 1976 per capita meat consumption returned to its pre-crisis levels and started slipping again, since 1978, to 180 lbs levels in the face of continuing high meat prices and despite the impact of inflation on the incomes of the middle and higher income classes. United States Department of Agriculture, "Livestock and Meat Outlook and Situation". Washington, D.C.: August 1981 and previous issues).

elasticities of demand, the animals for consumption by the rich may crowd out direct demand for the subsistence of the poor[13].

The linkage of the two markets, of grains for direct consumption and of those for animal feed, has a Janus-like double face. The beguiling aspect is that it can soften the blow on the poor at times of supply shortfalls. The ominous side is that it may crowd out subsistence consumption in the face of increasing demand by the middle-income classes. The undesirable effects of the market linkage can be obviated if a tax on meat consumption, rather than an increase in the price of animal feed, is used as a rationing mechanism. The problem with taxes is that they are of limited usefulness as instruments for *international* redistribution. A government would have only small incentive to tax meat consumption by the rich in order to release grains for the survival of the poor in a third country. At the level of *within-country* income distribution a tax would in principle be more effective, although in practice it may be difficult to impose because of the political power of the middle classes and the wealthy. For the same reasons indirect rationing devices, such as the proclamation of meatless days, could also be ineffective.

The market link can be broken by targeted programs which increase food-use versus feed-use. Group-targeting directs the grains to the poor through the issuing of rations and coupons or by disposing of them at fair price shops or in soup kitchens. The government often bears the entire cost of such programs or else it can partly offset it through an increase in the price of grains for the non-poor. As an example, the govenment can initiate a compulsory quota delivery of grains at low prices by producers and market intermediaries to be directed to the poor. The rest of the cereals are sold at the free market price which is substantially higher. Such a scheme need not even mean lowered (in terms of average prices received) incentive to either farmers or

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13. "Crowding out" reminds one of a physical phenomenon. Its use in economics, however, does not imply that the rich are literally threatening to eat up all the grain produced, but that the poor may find themselves with insufficient incomes to acquire a subsistence diet level under conditions of rising cereal prices.

intermediaries[14]. Commodity-targeting, on the other hand, favors the prices of the grains mainly consumed by the poor. In Bangladesh, for example, sorghum was sold in 1969 at ration shops at half the price of wheat and rice. The rural poor bought sorghum, while the urban poor in Dacca paid double the price and bought rice or wheat[15]. The question that arises is whether cheap sorghum also went to feed the animals for the protein diet of the middle class. Successful targeting, in other words, is often complicated. It becomes simpler if tastes change and shift direct consumption to cereals which are not market-linked with animal feed. Then a government's discretionary power of using tax and pricing policies to protect the consumption of cereals by the poor increases. The Japanese advertising campaign of "Good Life with Rice" can be interpreted as such an attempt, over and above its obvious intent to run down the stocks of highly protected rice that the government releases at subsidized prices to direct consumption[16].

It is true that competition for food has always been based at least partly on the demand for luxuries versus that for necessities. The competition, however, has much intensified in recent years since meat has become a very popular luxury among the members of the ballooning middle-income classes. Furthermore, the market link between food and feed creates the conditions for a type of market failure which limits the applicability of combined price and tax policies as instruments of distribution of the subsistence good to the poor.

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14. Y. Hayami, "Rice Policy in Japan's Economic Development", *American Journal of Agricultural Economics* 54 (January 1972): 19-31.

15. World Bank, *World Development Report, 1982*, Ch. 7.

16. In the meantime, suggests an anonymous reviewer, the Japanese government is covering all bases by trying hard to convince Japanese farmers to use rice as a livestock feed!

Conclusion and Policy Alternatives

It is currently becoming trendy to attribute hunger to poverty. Charles Shuman has coined a handsome phrase: "Hunger is not a technical necessity... Hunger is an economic problem - there are no hungry people where there is money to buy food"[17]. Ann Crittenden headlined in the *New York Times*: "Poverty Seen as the Overwhelming Cause of World Hunger"[18].

More than an economic phenomenon, hunger is a social phenomenon which has to do with the absence of a minimum threshold level of distributive equity. It may be that a minimum of direct intervention in basic food consumption is the only way to prevent the income elasticity of the wealthy from crowding out the demand of the poor.

If indeed income distribution is the proximate cause of hunger, what are the prospects for the future? Is it likely that World Hunger occurs through "crowding out"? Furthermore, why should the gradual improvement in incomes, which has been a secular phenomenon, have only now triggered such apocalyptic projections on the future shape of food supplies?

At least two factors have helped in the past to cushion the full impact of the new food-feed competition. First, mechanization released the constraint of the scarce factor of production and shifted land from providing for the supply of horse power, in the most literal sense, to raising food for direct or feed for indirect human consumption. Second, it is fortuitous that both mechanization and the incomes explosion came into full swing at a time of abundant fossil-fuels and cheap petroleum prices. Should the upward trend in oil prices recur and the production of fuel alcohol become an economic proposition, the food-feed-*fuel* competition that will ensue could have an ominous effect upon

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17. C.B. Shuman, "Food Aid and the Free Market", *Food Policy*, eds. P.G. Brown and H. Shue (New York, N.Y.: The Free Press, 1977): 145-163.

18. A. Crittenden, "Proverty Seen as the Overwhelming Cause of World Hunger", *New York Times* (December 7, 1981).

the poor of the world. A European-made automobile running on gasohol for 7000 miles a year would require an average of 3000 kgs. of grain[19]. Such a possible grain use makes even the most extravagant cereal consumption levels of 850 kgs. per capita per year (in the U.S.) pale into insignificance.

When it comes to the future, good fortune and the quick maturation of technological breakthroughs that may now be in the wings (application of the new plant and animal genetics? the promise of no-tillage farming?) could conceivably solve many problems. Even by applying a "more-of-what-we-already-know" approach, FAO has outlined a strategy that would increase agricultural production in LDCs by 3.7 percent per year and would more than double output between 1980 and 2000[20]. Such rates of growth, however, on a sustained basis, have been unprecedented in the annals of world agriculture.

A promising, feasible, and certainly the most appealing strategy for handling the food-feed dilemma in the years to come is to focus on production increases all around, and especially in LDCs. A revitalized agriculture could produce the crops to feed both people and animals in most countries and in the process it could also increase employment and improve the standard of living of a substantial segment of the poor, the farmers and farm workers. The endeavor will not be easy. But should it fail, a safety-valve exists in the abatement of income growth that would operate on the demand side. It is not popular to advocate even a marginal income redistribution that would change the eating habits of the rich. It would probably be difficult to implement. All the same, such a redistribution is already going on. Since international inflation affects more seriously the middle and upper income classes, it is likely to affect demand for feed more than that for food.

Greater emphasis on basic food self-reliance at the national level could be an effective strategy for coping with the food-feed

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19. L.R. Brown, "Food or Fuel - New Competition for the World's Cropland", (Washington, D.C.: Worldwatch Paper 35, March 1980).

20. Food and Agriculture Organization, *Agriculture: Toward 2000:* 124-125.

competition. The advantage of the approach is that it operates simultaneously both on the production and on the demand side[21]. Besides encouraging agricultural output at home, it also insulates the domestic market from the food-feed competition that takes place at the level of international trade. The basic staple consumption at home is not crowded out by the demand of the rich abroad as transmitted through international trade. The demand-side of self-reliance amounts to bringing down the competition for food between the rich and the poor, from the international gaps of inequality that range between 7÷1 and 13÷1, to the levels of the national gaps of regional inequality which typically range around 3÷1[22].

A.K. Sen has remarked that: "Starvation is the characteristic of some people not *having* enough food to eat. It is not the characteristic of there not *being* enough food to eat. While the latter can be the cause of the former, it is but one of the many possible causes"[23]. This paper focusses on "there not being enough food to eat" -both for the middle-income classes (indirectly) and for the poor (directly)- which often results in the poor not having enough to eat. This class competition is "new" because in historical experience countries first developed and

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21. A policy of self-reliance has well-known benefits and costs. Given the level of LDC cereal demand, a country gains (in domestic-resource-cost terms) by having access to the DC markets with their huge grain surpluses. Allowing for LDC demand to vary (by increasing the indirect consumption of cereals by middle-income classes) a country with a foreign exchange constraint may not be able to afford the luxury of cereal imports. The argument of self-reliance rests partly on the political and economic irreversibility of trade in cereals, the cost of which can become very large if food security is threatened by a world crisis. A country which has let agriculture go and relies on imports of the staple commodity cannot easily reverse policies to count on domestic supplies when international prices rise. Similarly, a country that has filled the middle-class demand for meat with cheap feed imports may be under strong domestic political pressure to continue doing so despite the rising costs of such imports.

22. J. Tinbergen, *RIO: Reshaping the International Order* (New York, N.Y.: E.P. Cutton and Co., 1976): 119.

23. A.K. Sen, *Poverty and Famines* (Oxford: Clarendon Press, 1981): 1.

then populous middle-income classes grew. It seems that in the modern version the growth of middle-income classes comes first, when a country can least afford them, and development follows - or is thwarted. This last statement about historical sequences, however, is provisional, pending further empirical evidence.

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